Patent Abstracts

These Patent Abstracts of recently issued patents are intended to provide the minimum information necessary for readers to determine if they are interested in examining the patent in more detail. Complete copies of patents are available for a small fee by writing: U.S. Patent and Trademark Office, Box 9, Washington, DC 20231.

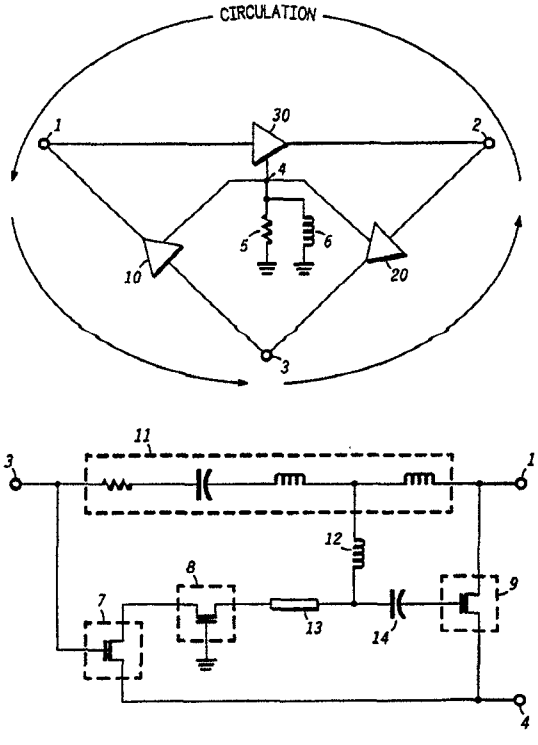
5,144,266 Sept. 1, 1992

Broad-Band High-Frequency Active MMIC Circulator

Inventors: Richard M. Dougherty and Stephen W. Boser.
Assignee: Motorola, Inc.
Filed: Feb. 4, 1991.

Abstract—A broad-band high-frequency active MMIC circulator which includes low parasitic devices (MESFET's or HEMT's) and shunt feedback for impedance contouring in conjunction with a cascode/cascade isolation/gain network. To achieve circulation, a common series feedback node is required for each active element. While conventional active circulator topologies require the use of a resistive element for operation with a deleterious effect on noise performance, this broad-band high-frequency active MMIC circulator functions with either resistive or reactive common series feedback. When reactive feedback is selected, major improvements in noise performance can be realized.

12 Claims, 1 Drawing Sheet



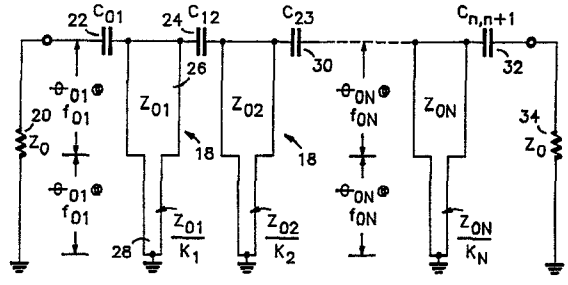
5,144,268 Sept. 1, 1992

Bandpass Filter Utilizing Capacitiviely Coupled Stepped Impedance Resonators

Inventor: John H. Weidman.
Assignee: Motorola, Inc.
Filed: June 20, 1991.

Abstract—A bandpass filter which lends itself to applications in the 500 megahertz to 1 gigahertz region. The filter utilizes the capacitively coupled bandpass filter as a model in the design process, but replaces the lumped element inductor/capacitor resonators with distributed stepped impedance resonators.

1 Claim, 1 Drawing Sheet



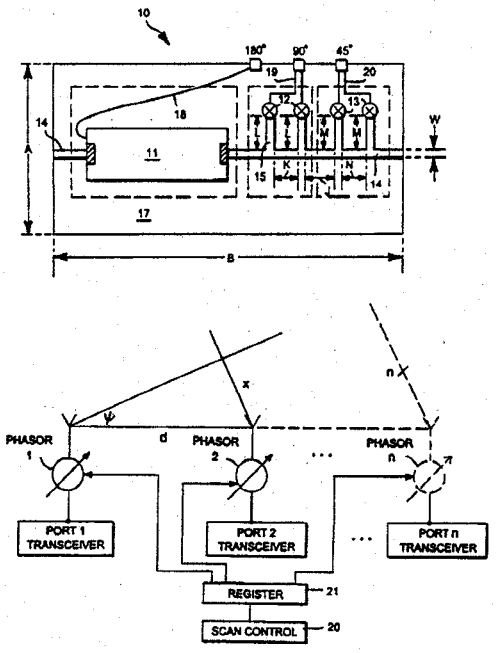
5,144,319 Sept. 1, 1992

Planar Substrate Ferrite/Diode Phase Shifter for Phased Array Applications

Inventor: Roger G. Roberts.
Assignee: Electromagnetic Sciences, Inc.
Filed: Mar. 14, 1991.

Abstract—An RF phase shifter combines a non-reciprocal ferrite 180° stage with one or more reciprocal diode phase shifting stages to produce an essentially planar phase shifter that is ultra small, efficient and lightweight. Such phase shifter elements may be used in phased arrays to produce an array offering major improvements over existing planar substrate all diode phase shifters while maintaining the phase gradient between array elements and without switching the ferrite shifter between the transmit and receive modes.

32 Claims, 2 Drawing Sheets



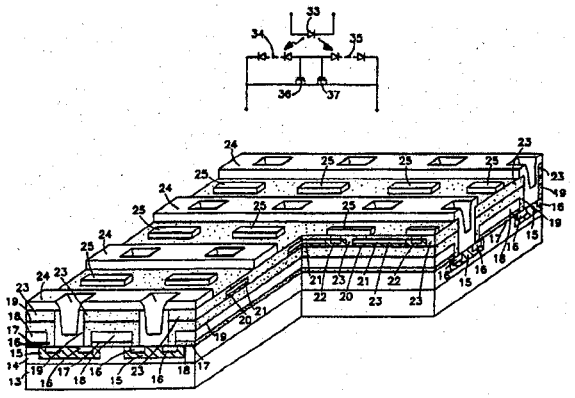
5,144,395 Sept. 1, 1992

Optically Driven Semiconductor Device

Inventors: Toshiaki Miyajima, Kazumasa Kioi, Mituo Matunami, Tukasa Doi, Minoru Yoshioka, and Masayoshi Koba.
Assignee: Sharp Kabushiki Kaisha.
Filed: Mar. 19, 1991.

Abstract—An optically driven semiconductor device is disclosed which comprises a semiconductor substrate, a plurality of vertical field effect transistors formed on the substrate, and a plurality of optoelectric transducers formed on an insulating film above the respective transistors, wherein the transistors have the substrate in common as a drain. Also disclosed is an optically driven semiconductor device which comprises a semiconductor substrate, a vertical field effect transistor formed on the substrate and a solar cell formed on an insulating film above the substrate, wherein the solar cell is formed with a polycrystalline silicon layer or monocrystalline silicon layer grown by the chemical vapor deposition method. Moreover, there are disclosed optically coupled semiconductor relay devices using these optically driven semiconductor devices.

8 Claims, 9 Drawing Sheets



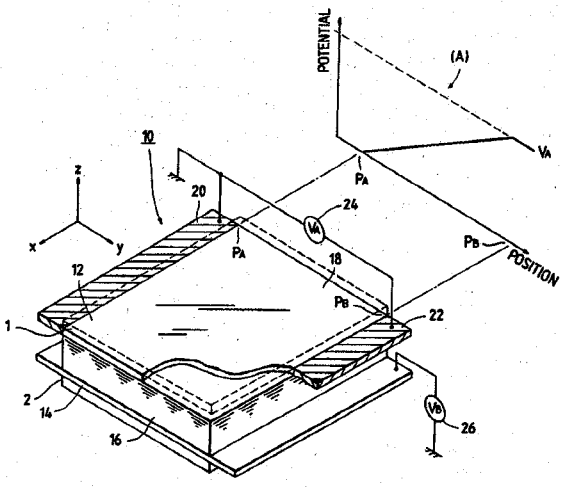
5,144,471 Sept. 1, 1992

Optical Scanning System for Scanning Object with Light Beam and Displaying Apparatus

Inventors: Itsuo Takanashi, Shintaro Nakagaki, Tsutou Asakura, Masato Furuya, Tetsuji Suzuki, and Hirohiko Shinonaga.
Assignee: Victor Company of Japan, Ltd.
Filed: June 26, 1990.

Abstract—An electromagnetic radiation beam scanning system for scanning an object with an electromagnetic radiation beam. The scanning system comprises first and second beam-narrowing devices which are arranged so as to have elongated light-transmission regions, respectively, and which are overlapped each other so that the light-transmission regions intersect each other. Each of the beam-narrowing devices includes a light modulation layer showing an electro-optic effect, first and second electrodes disposed so as to sandwich the light modulation layer, first and second polarizers disposed so as to sandwich the light modulation layer and a power source for applying voltages to the first and second electrodes. The light modulation layer combined with the polarizers forms the elongated light-transmission region in response to application of the voltages to the first and second electrodes due to the power source so as to produce a narrowed beam when a light beam is incident thereon. The position of each of the light-transmission regions in each of the first and second beam-narrowing devices is arranged to be movable in response to variation of at least one of the application voltages due to the power source.

10 Claims, 7 Drawing Sheets



5,144,637 Sept. 1, 1992

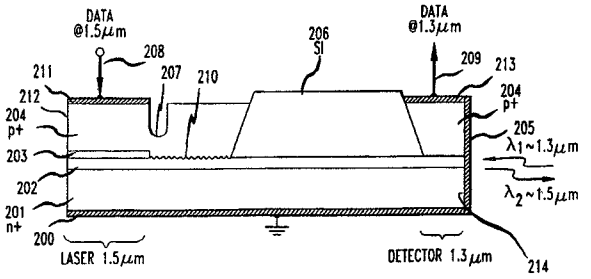
Inline Diplex Lightwave Transceiver

Inventors: Thomas L. Koch, Herwig Kogelnik, and Uziel Koren.
Assignee: AT&T Bell Laboratories.
Filed: Apr. 30, 1990.

Abstract—Full duplex lightwave communications is achieved in a diplex transceiver realized in a semiconductor photonic integrated circuit having an inline interconnecting waveguide integral with the transmitting and receiving portions of the transceiver. Semiconductor lasers and detectors operating in different wavelength regimes permit diplex or wavelength-division-multiplexed operation. In the transceiver, lightwave signals from the

laser propagate through the detector without interfering with the detector operation or the lightwave signals being detected.

8 Claims, 3 Drawing Sheets



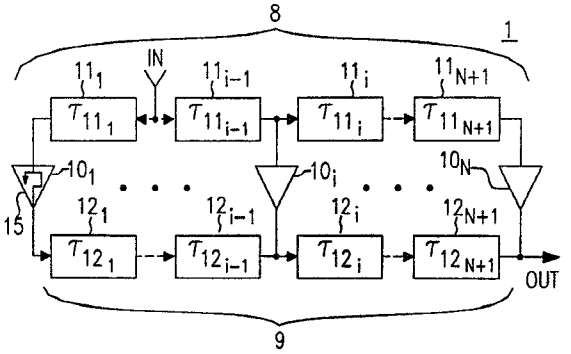
5,146,175 Sept. 8, 1992

Combining Technique for a Multistage, Parallel Amplifier

Inventor: Donald R. Green, Jr.
Assignee: AT&T Bell Laboratories.
Filed: Aug. 21, 1991.

Abstract—A reduced loss coupling technique for combining multiple, parallel, gain-stages to form an amplifier. A first transmission line, with multiple taps, couples the inputs of the gain-stages together and to an input port for the amplifier. A second transmission line, also with multiple taps, couples the outputs of the gain-stages together and to an output port for the amplifier. Preferably, the output port is connected to the end of the second transmission line while the input port is connected asymmetrically (off center) along the first transmission line. The actual position of the input port along the first transmission line is determined by the desired amount of phase mismatch of between signal paths through all of the gainstages as measured from the input port to the output port.

12 Claims, 2 Drawing Sheets



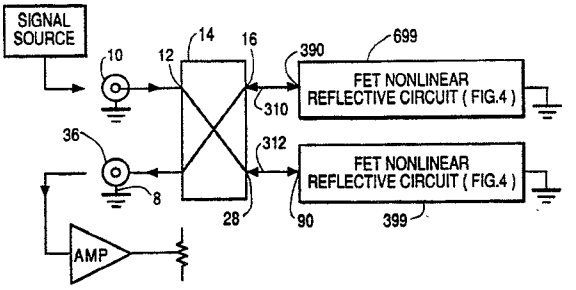
5,146,177 Sept. 8, 1992

Balanced Reflective Nonlinear Processor Using FET's

Inventors: Allen Katz and Shabbir S. Moochalla.
Assignee: General Electric, Co.
Filed: Aug. 30, 1991.

Abstract—A nonlinear processor for use as a signal limiter or predistortion equalizer includes a four-port, 3dB directional coupler. Signal to be distorted is applied to a first port of the coupler, and is coupled by second and third ports to a pair of nonlinear circuits. Each nonlinear circuit includes the source-to-drain transmission path of a FET. Each nonlinear circuit is grounded or short-circuited, to form a nonlinear reflective circuit which reflects the energy back to the associated port of the coupler. The nonlinearly reflected energy is received at the two coupler ports, and is combined and made available at the fourth coupler port. The input return loss of the processor is improved by matching the nonlinear circuits to each other.

13 Claims, 7 Drawing Sheets



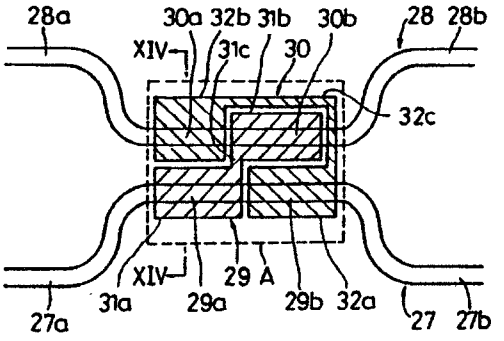
5,146,518 Sept. 8, 1992

Optical Directional Coupler Device and a Method of Driving Same

Inventors: Hon-Ming Mak and Hisaharu Yanagawa.
Assignee: The Furukawa Electric Co., Ltd.
Filed: Mar. 25, 1991.

Abstract—There is provided an optical functional device having a coupling portion in which two optical waveguides formed of semiconductor material are evanescent-coupled to each other and arranged in parallel and comprising voltage application electrodes electrically connected to each other and disposed on an upstream side portion of one of the two optical waveguides and a downstream side portion of the other optical waveguide and current injection electrodes electrically connected to each other, disposed on an downstream side portion of the former one of the two optical waveguides and an upstream side portion of the other optical waveguide and electrically isolated from the voltage application electrodes; wherein N-stage (N is an integer larger than 2) electrodes of reversal $\Delta\beta$ structure are continuously disposed in the optical waveguide, first electrodes electrically connected to each other are disposed on the upstream side portion of one of the two optical waveguides and the downstream side portion of the other optical waveguide between an Mth (M is an integer which satisfies the relation that $1 \leqq M \leqq N-1$) stage electrode and an $(M+1)$th stage electrode and second electrodes which are electrically connected to each other but are electrically separated from the first electrodes are disposed on the downstream side portion of the former one of the two optical waveguides and the upstream side portion of the other optical waveguide. The optical functional divice can be operated as an optical splitter or polarization switch by combining the current injection operation and the voltage application operation with respect to the electrodes.

6 Claims, 16 Drawing Sheets



5,146,519 Sept. 8, 1992

Rotary Variable Optical Tap

Inventors: William J. Miller and Alan J. Morrow.
Assignee: Corning Incorporated.
Filed: Aug. 28, 1990.

Abstract—An apparatus for selectively transmitting input optical signals carried on input optical fibers to output optical fibers. A three refractive index tapered wave guide structure is bent and maintained in the bent state. This structure is, thereafter, rotated in the bent state. The coupling characteristics are tunable based on the degree of rotation.

6 Claims, 4 Drawing Sheets

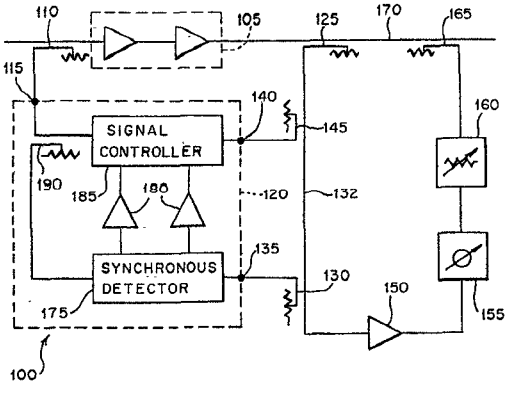
5,148,117 Sept. 15, 1992

Adaptive Feed-Forward Method and Apparatus for Amplifier Noise Reduction

Inventor: Ashok K. Talwar.
Assignee: American Nucleonics Corporation.
Filed: Nov. 25, 1991.

Abstract—An adaptive feed-forward cancelling system obtains a reference signal and a sample signal from an amplifier by directional couplers. The sample signal essentially consists of an undistorted input signal component and a noise and distortion component. The reference and sample signals are provided to an adaptive interference canceller which performs an adaptive cancellation process. The interference canceller provides a cancellation signal essentially consisting of the signal component which is common to both the reference signal and the sample signal. The cancellation signal is injected into a transmission line which carries to sample signal so that only an error signal remains which essentially consists of the noise distortion component of the amplifier output signal. The error signal is then amplitude and phase adjusted to have substantially the same amplitude and to be substantially 180° out of phase with the amplifier output signal. The amplitude and phase adjustment error signal is then injected by a directional coupler onto the transmission line which carries the amplifier output signal so that an amplified input signal is provided by the power amplifier without the noise and distortion components added by the amplifier.

8 Claims, 2 Drawing Sheets



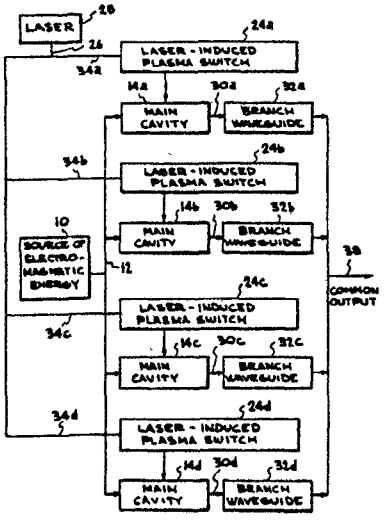
5,148,129 Sept. 15, 1992

Microwave Pulse Compression from a Storage Cavity with Laser-Induced Switching

Inventor: Paul R. Bolton.
Assignee: The United States of America as represented by the United States Department of Energy.
Filed: June 20, 1991.

Abstract—A laser-induced switch and a multiple cavity configuration are disclosed for producing high power microwave pulses. The microwave pulses are well controlled in wavelength and timing, with a quick rise time and a variable shape and power of the pulse. In addition, a method of reducing pre-pulsed leakage to a low level is disclosed. Microwave energy is directed coherently to one or more cavities that stores the energy in a single mode, represented as a standing wave pattern. In order to switch the stored microwave energy out of the main cavity and into the branch waveguide, a laser-actuated switch is provided for the cavity. The switch includes a laser, associated optics for delivering the beam into the main cavity, and a switching gas positioned at an antinode in the main cavity. When actuated, the switching gas ionizes, creating a plasma, which becomes reflective to the microwave energy, changing the resonance of the cavity, and as a result the stored microwave energy is abruptly switched out of the cavity. The laser may directly pre-ionize the switching gas, or it may pump an impurity in the switching gas to an energy level which switches when a pre-selected cavity field is attained. Timing of switching the cavities is controlled by varying the pathlength of the actuating laser beam. For example, the pathlengths may be adjusted to output a single pulse of high power, or a series of quick lower power pulses.

18 Claims, 7 Drawing Sheets



5,148,130 Sept. 15, 1992

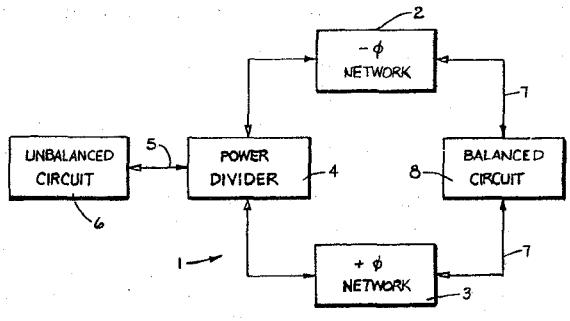
Wide-Band Microstrip UHF Balun

Inventor: James L. Dietrich.
Filed: June 7, 1990.

Abstract—A wide-band balun for converting between unbalanced and balanced signals and impedances utilizes two single-ended networks connected in parallel at the unbalanced side. The networks provide equal power split and equal phase slopes with midband phase shifts of +90 and −90 degrees in order to give equal-amplitude, anti-phase balanced outputs over an octave or more

bandwidth. Printed circuits construction including a folded microstrip line provides an effective implementation at UHF frequencies.

16 Claims, 4 Drawing Sheets



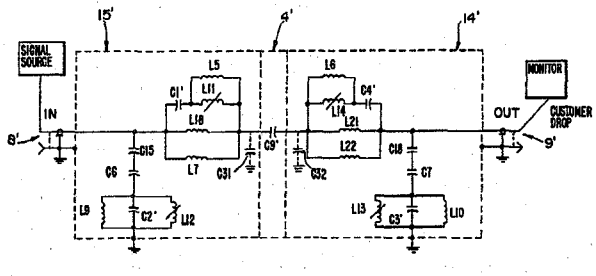
5,148,133 Sept. 15, 1992

Quality Factor Improvement for Filter Applications

Inventors: Joseph A. Zennamo, Jr. and Gary J. Clark.
Assignee: Eagle Comtronics, Inc.
Filed: May 29, 1991.

Abstract—A tuned filter having an improved Q is disclosed in which two or more inductors are placed in parallel to increase the net Q relative to a single inductor of the same net inductance and/or two or more capacitors are placed in series to increase the net Q relative to a single capacitor of the same net capacitance to improve the Q of a tuned filter.

11 Claims, 9 Drawing Sheets



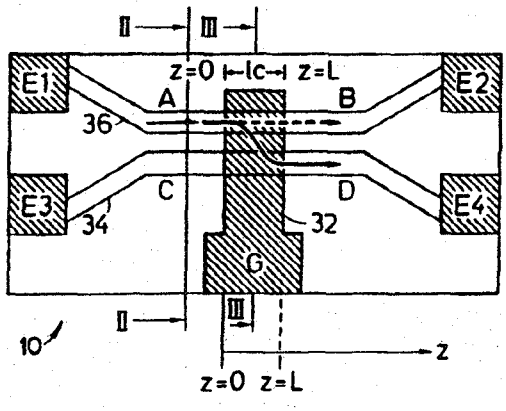
5,148,242 Sept. 15, 1992

Electron-Wave Coupled Semiconducto Switching Device

Inventors: Noriaki Tsukada and Klaus Ploog.
Assignee: Max Planck Gesellschaft zur Foerderung der Wissenchaften e.V.
Filed: Jan. 22, 1991.

Abstract—An electron-wave coupled semiconductor device, in particular a semiconductor switching device, comprises a first layer of semiconducting material having a first bandgap, and a second layer of material formed on said first semiconducting layer and having a second bandgap greater than the first said bandgap. First and second electron waveguides are formed alongside but spaced apart from each other in the first semiconductor layer adjacent the boundary between this layer and said second layer. A gate region extends over said second layer transverse to and over said electron waveguides. First contact means provides input connections to said first and second electron waveguides on one side of said gate region and further contact means provides separate output connections from said first and second electron waveguides on the opposite side of the gate region from said first contact means. The dimension of the electron waveguides under said gate region, both along and transverse to said electron waveguides, and also the dimension between said electron waveguides are smaller than the elastic mean free path for electrons at the operating temperature of the device. A signal applied to the gate region can be used to switch a signal applied to said input contact means selectively to a selected one of the output connections.

29 Claims, 9 Drawing Sheets



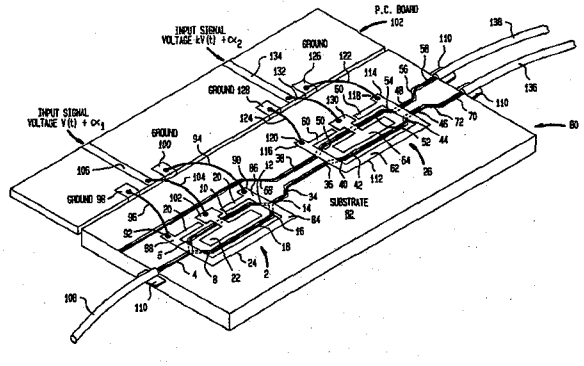
5,148,503 Sept. 15, 1992

Apparatus and Method for Linearized Cascade Coupled Intergrated Optical Modulator

Inventor: Halvor Skeie.
Assignee: Crystal Technology, Inc.
Filed: May 29, 1991.

Abstract—A Y-branch type first interferometric modulator, and a coupler structure type second interferometric modulator are connected in cascade. The levels of dc bias voltages applied to the first and second interferometric modulators, respectively, are adjusted for maximizing the linearity of a modulated output light signal. The configuration of input and output coupler structures of the second interferometric modulator are predetermined for also contributing to maximizing the linearity of the output signal.

23 Claims, 4 Drawing Sheets



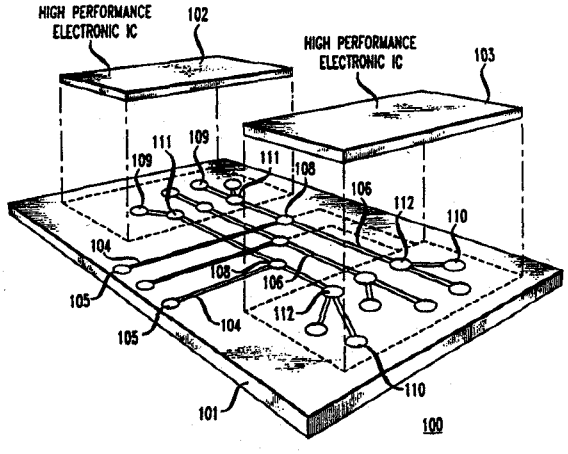
5,148,504 Sept. 15, 1992

Optical Integrated Circuit Designed to Operative by Use of Photons

Inventors: Anthony F. J. Levi, Samuel L. McCall, and Richart E. Slusher.
Assignee: AT&T Bell Laboratories.
Filed: Oct. 6, 1991.

Abstract—Optical integrated circuitry, performing various of the functions associated with electronic integrated circuitry, is disclosed. Fabrication, importantly to achieve high circuit chip density—typically in the range of 10^6 as including both devices and interconnecting guides—is dependent upon device/spacing dimension miniaturization resulting from fabrication in very thin layers. Typical layer thickness as retained in fabricated devices and guides, of a maximum of the order of a $1/2$ wavelength for relevant photon flux, results in limitation in cross-talk to permit device design rules of one or a few wavelengths.

22 Claims, 6 Drawing Sheets



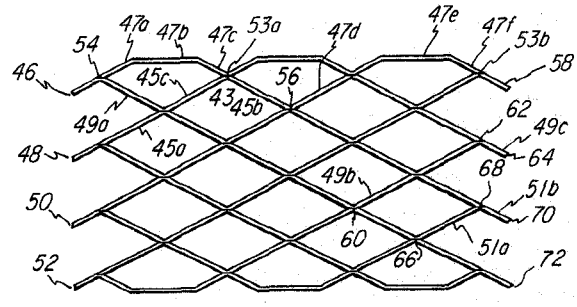
5,148,506 Sept. 15, 1992

Optical Crossbar Switch

Inventor: T. Gus McDonald.
Assignee: Texas Instuments Incorporated.
Filed: Dec. 10, 1991.

Abstract—There is disclosed a micro-mechanical switch mounted on a waveguide structure that can be utilized as a switching device in optical networks. The device comprises an individually deflectable element suspended over a gap in a waveguide. The individually deflectable element has attached to its underside a vertical metal shutter which can be raised or lowered by the movement of the element. The raising or lowering of the shutter is used to control light propagating through the waveguide.

8 Claims, 7 Drawing Sheets



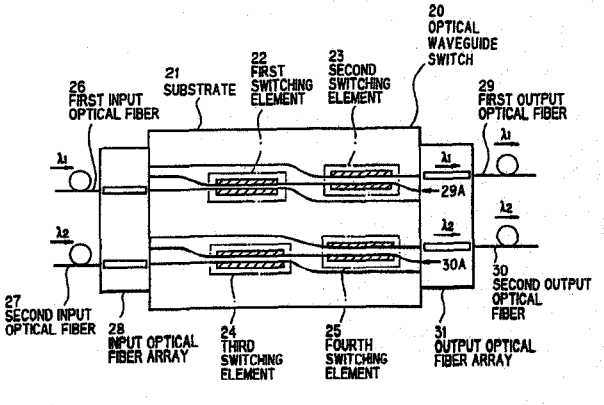
5,148,507 Sept. 15, 1992

Optical Waveguide Device with Two Predetermined Wavelength, Polarization Independent, Directional Coupler Switches

Inventor: Yasuhisa Tanisawa.
Assignee: NEC Corporation.
Filed: July 8, 1991.

Abstract—In an optical waveguide device, a plurality of optical directional coupler switches are provided on a substrate, and light input and output terminals are also provided to be coupled to the optical directional coupler switches. Each of the optical directional coupler switches is provided with a pair of parallel waveguides. One of the optical directional coupler switches operates independently of the polarization of light having a first predetermined wavelength by defining a width of the parallel waveguides and a distance therebetween to be first predetermined values, and one of the optical directional coupler switches operates independently of the polarization of light having a second predetermined wavelength by defining a width of the parallel waveguides and a distance therebetween to be second predetermined values. The parallel waveguides of the first and second ones of the optical directional coupler switches are provided by diffusing films of the same thickness deposited in a predetermined pattern on the substrate thereinto by a predetermined diffusing condition.

5 Claims, 13 Drawing Sheets



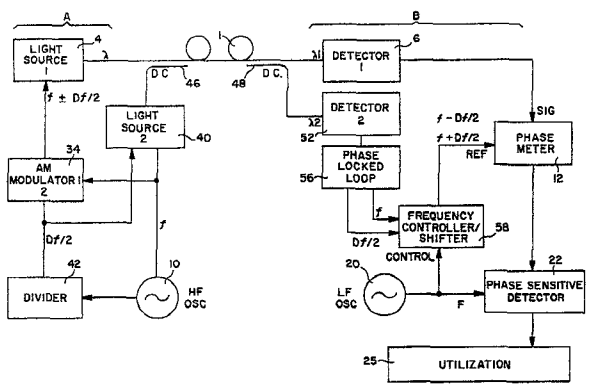
5,149,961 Sept. 22, 1992

Method and Apparatus for Optical Fiber Length Determination

Inventors: Timothy G. Arnold and Arthur J. Barlow.
Assignee: EG&G, Ltd.
Filed: Apr. 24, 1991.

Abstract—In a method and apparatus for measuring length of an optical fiber, a light source of a selected wavelength transmitted along the fiber is modulated by both a first and a second light modulation signal, which light modulation signals each differ in frequency from a first modulation frequency by a fixed amount. A time detector responds, alternately during a period, to the light signal as modulated by of each of the first and second light modulation signals by using each of the light signal modulation frequencies as a reference. Consequently, the output of the time detector has a phase responsive to the effective length of the fiber. A phase sensitive detector receives as a signal input an output of the time detector means. A second modulation frequency defines the period of alternation of response and provides a reference input to the phase sensitive detector. The phase sensitive detector measures the ac component of time detector output in phase with the second modulation frequency to provide an indication of fiber length.

11 Claims, 3 Drawing Sheets



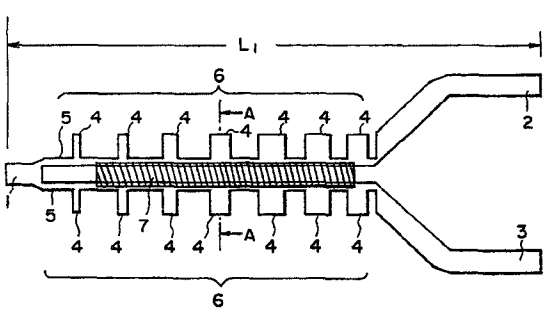
5,150,084 Sept. 22, 1992

Power Divider

Inventors: Masahito Asa and Masayuki Nakajima.
Assignee: Tokimec, Inc.
Filed: Feb. 28, 1991.

Abstract—A distributed-line power divider comprising: a common port and n distributing ports adapted to be connected with respective external lines; and n impedance transformers disposed between the common port and the distributing ports and having a filter function. The filter function of the impedance transformers may be a low-pass filter, a high-pass filter or a band-pass filter.

21 Claims, 7 Drawing Sheets



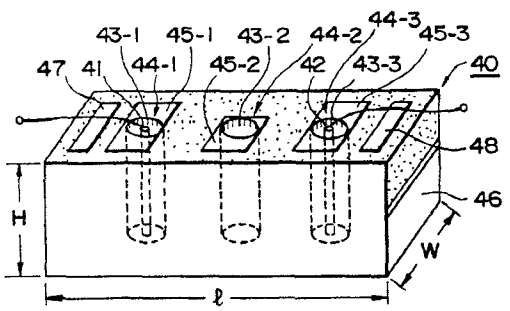
5,150,089 Sept. 22, 1991

Dielectric Filter Having an Attunuation Pole Tunable to a Predetermined Frequency

Inventors: Tomokazu Komazaki, Katsuhiko Gunji, Norio Onishi, and Akira Mashimo.
Assignee: Oki Electric Industry Co., Ltd.
Filed: Dec. 26, 1990.

Abstract—A dielectric filter includes a homogeneous monolithic block of dielectric material having a plurality of parallel extending dielectric resonators formed therein. A plurality of first electrodes extend along the top surface of the monolithic block, each encompassing an opening in the monolithic block defined by a corresponding one of the plurality of dielectric resonators. Either the distance between adjacent dielectric resonators or the configuration of the first electrodes is established to cause an overcoupling based on the coupling impedance, thereby tuning an attenuation pole of the dielectric filter to a finite frequency. Additionally, second electrodes are provided along the top surface of the monolithic block extending between and spaced from the first electrodes and connected to a ground electrode.

1 Claim, 10 Drawing Sheets



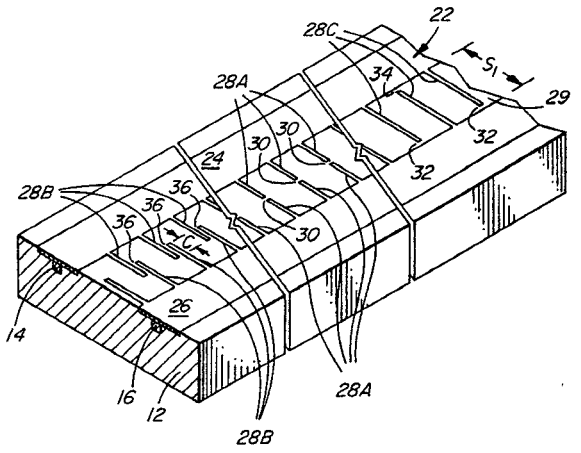
5,150,436 Sept. 22, 1992

Slow-Wave Electrode Structure

Inventors: Nicolas A. F. Jaeger and Zachary K. F. Lee.
Assignee: The University of British Columbia.
Filed: Sept. 6, 1991.

Abstract—A slow-wave electrode structure suitable for use in integrated optical modulators having a pair of spaced substantially parallel integrated optical waveguides in a compound semi-conductor substrate (such as gallium arsenide (GaAs) or indium phosphide (InP)) is formed by a pair of substantially parallel conductor strips on the surface of the substrate each in a position for interaction with its respective adjacent of said waveguides. The conductor strips are capacitively interconnected by narrow fins each integral with one of the strips and extending between the strips whereby the conducting strips and fins may be applied as a single layer to the substrate. The narrow fins significantly increase the capacitance per unit length between the strips without an equivalent decrease in inductance per unit length along the strips such that the phase velocity of the microwave signals is reduced.

21 Claims, 3 Drawing Sheets



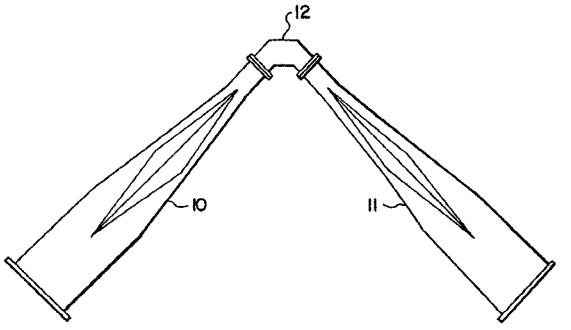
5,151,673 Sept. 29, 1992

Compact Bend for TE_{01} Mode Circular Overmoded Waveguide

Inventor: Jeffery W. Waarren.
Assignee: The Johns Hopkins University.
Filed: July 29, 1991.

***Abstract*—A compact waveguide bend structure having high power handling capability, particularly designed for use with TE_{01} circular overmoded waveguide, comprises a transition from circular overmoded waveguide to rectangular overmoded waveguide (using the TE_{20} mode), followed by a TE_{20} mode rectangular waveguide bend, and a transition back to circular overmoded waveguide.**

5 Claims, 2 Drawing Sheets



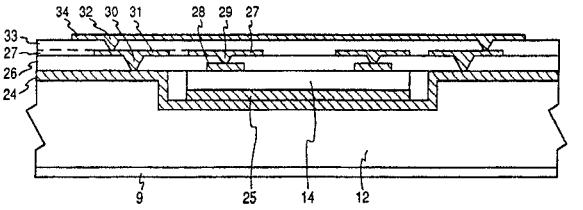
5,151,769 Sept. 29, 1992

Optically Patterned RF Shield for an Integrated Circuit Chip for Analog and/or Digital Operation at Microwave Frequencies

Inventors: Anthony A. Immorlica, Jr. and Rober F. Chase.
Assignee: General Electric Company.
Filed: Apr. 4, 1991.

***Abstract*—The invention relates to the provision of an RF shield for an individual or a collection of integrated circuit chips in a module containing a plurality of hybrid interconnected chips generating interfering RF fields that would interfere with operation of that chip if unshielded. The chips in the module may function in the analog and/or digital mode. The RF shield comprises separate metallizations under and over the chip, the two metallizations being interconnected by a line of discrete electrically conductive vias forming cage-like sides to complete an electrically conductive enclosure about the chip. The vias are spaced closely enough to prevent the escape or entry of RF waves at the frequencies of interest. The RF shield is advantageously fabricated using metallizations and vias that are optically patterned by the same process steps used to effect hybrid interconnection of the chips.**

7 Claims, 2 Drawing Sheets



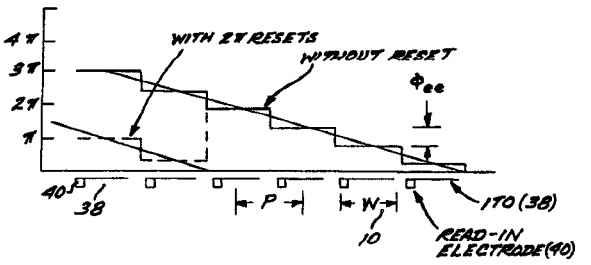
5,151,814 Sept. 29, 1992

Phased Array for Optical Beam Control

Inventors: Jan Grinberg, Thomas R. O'Meara, Yuri Owechko, Melvin E. Pedinoff, and Bernard H. Soffer.
Assignee: Hughes Aircraft Company.
Filed: Mar. 18, 1991.

***Abstract*—An optical beam scanner incorporating an array of beam deflection elements commonly controlled to steer an optical beam impingent on the array is described. The beam steering elements are arranged in the array as individually controlled elements and the deflection of the beam is accomplished by setting the phase tilt and the phase offset of each element according to a calculation which removes modulo 2π phase shift from the required position relative to a flat plane. Thus, the array elements can be thin and need only supply about 2 radians of phase shift. These elements may be incorporated in a planar array using beam deflection elements such as liquid crystal beam deflectors by choosing a drive scheme representing either a blazed array or a flat piston array. Operation may be designed for a large range of light wavelengths and the system may efficiently accommodate a combination of the blazed and flat piston techniques to obtain beam deflection characteristics otherwise unavailable by the exclusive use of each individual technique. By use of the liquid crystal phase array approach, rapid, high accuracy, large area beam deflection is possible without the necessity of any moving parts and with low power drive requirements. Phased arrays of the type described above may be arranged in successive parallel planes with a common beam axis to provide two-dimensional beam deflection.**

5 Claims, 12 Drawing Sheets



5,151,817 Sept. 29, 1992

Optical Frequency Second Harmonic Generator

Inventors: Denise M. Krol and Jay R. Simpson.
Assignee: AT&T Bell Laboratories.
Filed: May 8, 1991.

Abstract—Applicants have discovered photo-induced second harmonic generation in rare earth doped glass bodies free of germanium. Moreover, applicants have discovered that multivalent rate-earth doped glass bodies can be made with conversion efficiency of second harmonic generation in excess of 10^{-3}% per watt, exceeding the reproducible efficiency of germanium doped glass. In accordance with the invention, a light source of a desired frequency comprises a body of glass doped with a multivalent rare earth element, an optical input source of light at one-half the desired frequency, and utilization means for receiving light passing through said body and utilizing light at the desired frequency.

9 Claims, 1 Drawing Sheet